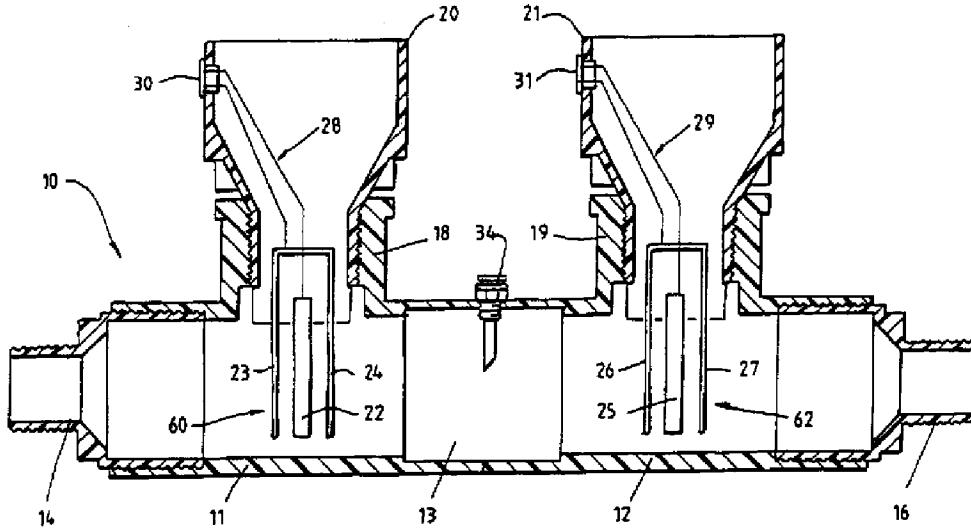




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## (54) Title: LIQUID STERILISATION APPARATUS



## (57) Abstract

The invention provides a liquid purification apparatus (10) adapted to employ the combination of the purifying effects of the heavy metals copper and silver in conjunction with hydrogen peroxide and the catalytic reaction thereof. A body means (11, 12) defines a flow passage (13) having a liquid inlet (14) at one end and a liquid outlet (16) at the other end. Flow passage (13) has a first electrolytic unit (60) containing at least one copper based anode (22) and a second electrolytic unit (62) containing at least one silver based anode (25) spaced downstream of first electrolytic unit (60). An electrical circuit means (32) supplies operating current thereto and flow passage (13) includes an inlet (34) for the controlled introduction of H<sub>2</sub>O<sub>2</sub> from reservoir means (51) into flow passage (13) between first (60) and second (62) electrolytic units.

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## LIQUID STERILISATION APPARATUS

### TECHNICAL FIELD OF THE INVENTION

This invention relates to liquid purification apparatus and methods of using same. The invention is directed to apparatus for purifying water by the well-known process of heavy metal purification using the bacteriostatic effects of silver, as well as the algaecidal effect of copper, whilst hydrogen peroxide is introduced because of its catalysed decomposition by either one or both of these metals to produce oxygen. The invention will be described in the preferred embodiments in its particular application in destroying disease-carrying bacteria in drinking water, but it will become apparent that the invention is not limited to this particular field of use, with wider and different applications being possible.

### BACKGROUND OF THE INVENTION

As is well known and made the subject of the prior art, the high affinity that Ag<sup>+</sup> ions have to -SH and other groups makes it an efficient biocide. If hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) is simultaneously added the former causes a catalytic reaction with the H<sub>2</sub>O<sub>2</sub> to increase the efficiency quite considerably as H<sub>2</sub>O<sub>2</sub> is also a biocide.

As a result, this process can be used to sterilise drinking water, or water that may be in contact with humans, such as water in pools, spas and the like.

Various attempts have been made in the past to devise apparatus and methods for the effective use of metal ions of silver and copper with H<sub>2</sub>O<sub>2</sub>, but for a number of reasons success has not been attained. In consequence, no marketable technology is currently available, due mainly to difficulties in handling the H<sub>2</sub>O<sub>2</sub> and controlling the dosages required. Many prior proposals have involved usage systems requiring labour intensive packaging in an endeavour to achieve accurate levels of all three additives, namely Ag<sup>+</sup>, copper and H<sub>2</sub>O<sub>2</sub>. For example, U.S. specification No. 2,105,835 of Krause

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prescribed individual packaging, using tablet form, enclosed in soluble wrappings which gradually dissolve, encased in soluble crystals, powder mixes, adding to ice, and so forth. Likewise, United Kingdom specification No. 432101 of Katadyn A,G, discloses the use 5 of packets, tablets, pills, capsules or ampoules, soluble coating of crystals or gelatine. Thus in the prior art the dosing of metals and H<sub>2</sub>O<sub>2</sub> involved cumbersome procedures and apparatus, with the apparatus also being expensive to manufacture, and in the main only specific predetermined bodies of water could be treated.

10 A major problem with the prior art arose from the fact that the handling of H<sub>2</sub>O<sub>2</sub> to perform the aforementioned functions had been found dangerous and likely to prove harmful to users. The strength of H<sub>2</sub>O<sub>2</sub> required was between 30 to 50% strength, and this made it dangerous bearing in mind that H<sub>2</sub>O<sub>2</sub> at even 8% strength is an 15 irritant to the skin and is corrosive at 20%. To dose any large amount of water, such as 50,000 litres, using 15% strength H<sub>2</sub>O<sub>2</sub> would require a massive volume of hydrogen peroxide, and obviously dosing with H<sub>2</sub>O<sub>2</sub> at 50% strength would pose a serious health threat to the user.

20 **OBJECTS OF THE INVENTION**

The present invention has as its principal object to provide 25 apparatus which will ameliorate at least some of the problems associated with the prior proposals by effectively controlling the dosages of silver ion release and copper ion release, as well as the supply of H<sub>2</sub>O<sub>2</sub> relative to a predetermined and controlled flow of water which is subjected to said dosage, in a manner achieving both safety and increased efficiency of operation.

A further object of the invention is to provide apparatus of the type just described which will allow effective control of the dosing 30 of the H<sub>2</sub>O<sub>2</sub> and the metals within an in-line flow passage for the

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water, regardless of the volume being passed, or the actual flow rate, and regardless of contamination present.

Yet another object of the invention is to provide such apparatus and usage methods which will ensure that the opportunity of the  $H_2O_2$  to come into contact with the user will be eliminated, while at the same time the dosing system will allow the introduction of all and any of the aforesaid elements, while avoiding wastage of any products involved and eliminating the production of chemical by-products eg hydroxides.

10 Other objects and advantages will be hereinafter apparent, such as providing advantages over the prior art in that the apparatus will not be subject to operational difficulties in areas where temperature variations may be extreme.

#### SUMMARY OF THE INVENTION

15 With the foregoing and other objects in view, the invention provides a liquid purification apparatus adapted to employ the combination of the purifying affects of the heavy metals copper and silver in conjunction with hydrogen peroxide and the catalytic reaction thereof, said apparatus including body means defining a  
20 flow passage having a liquid inlet at one end and a liquid outlet at the other end, said flow passage containing a first electrolytic unit containing at least one copper based anode, a second electrolytic unit containing at least one silver based anode spaced downstream of said first electrolytic unit, electrical circuit means being provided  
25 in association with the electrolytic units for supplying operating current thereto, and said flow passage including an inlet for the controlled introduction of  $H_2O_2$  from reservoir means into said flow passage between said first and second electrolytic units.

30 The invention has a number of other broad aspects which will be apparent from the later described and illustrated embodiments which serve to show the many variations which may be selected. In

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a simple form, two identical inverted T-shaped housings may be connected in line so that they have a single inlet at one end and a single outlet at the other for connection to respective supply and delivery lines, with a single flow line therebetween into which the 5 copper and silver electrolytic units extend radially from the upper body parts, both units being fitted in such manner that they may be easily removed when desired.

Typically, the silver electrolytic unit will comprise a single anode of silver having a pair of stainless steel cathodes at equal distances 10 on opposite sides, all three suitably being in a radial plane extending longitudinally of the flow line. Similarly the copper electrolytic unit has a single copper anode and two stainless steel cathodes arranged in the same way and the same relative dispositions as just described for the silver unit, all cathodes and anodes being coplanar and having 15 their free ends projecting into the chamber defining the flow line, while the opposite or fixing ends of the cathodes and anodes are connected to each other in each respective unit.

#### BRIEF DESCRIPTION OF DRAWINGS

In order that the invention may be more readily understood and 20 put into practical effect, reference will now be made to the accompanying drawings, wherein:-

Fig. 1 shows schematically in elevational view the overall general arrangement of a first embodiment of a water purification apparatus according to the invention;

25 Fig. 2 shows in greater detail and in cross-sectional side elevation the two interconnected bodies or housings shown at the bottom of Fig. 1;

Fig. 3 shows in greater detail the electrical circuit means for the silver anode and copper anode units;

30 Fig. 4 shows the steel connecting tube for the  $H_2O_2$  reservoir;

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Fig. 5 shows an enlarged view of the cutting tip of the steel connecting tube shown in Fig. 4;

Fig. 6 is a cross sectional side elevation of two interconnected bodies or housings, similar to that shown in Fig. 2, but showing an alternative arrangement employing three similar electrodes;

Fig. 7 is the power supply and wiring circuit diagram for the alternative arrangement shown in Fig. 6;

Fig. 8 is a schematic drawing showing the anode distribution and wearing mode provided by the alternative arrangement shown in Fig. 6, when the central electrode is acting as an anode; and

Fig. 9 is a similar view to that of Fig. 8 with the central electrode acting as an cathode.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

The apparatus shown in the drawings includes a treatment housing 10 having two interconnected bodies 11 and 12 defining a horizontal flow chamber or flow line 13 between an inlet end 14 connected to a supply pipe 15 and an outlet end 16 connected to a delivery pipe 17. Each body 11 and 12 has a top branch part 18 or 19 fitted with threadedly removable upper assemblies 20 and 21. The bodies 11,12 are preferably made of P.V.C. or other suitable material and have aligned or coaxial cylindrical chambers for the inlet end 14 and outlet end 16. The top branch parts 18 or 19 are perpendicular to flow line 13 and are fitted with electrodes and electrical connectors. In normal usage disposition of the apparatus, the aligned housings or bodies 11 and 12 have their axes contiguous and horizontal, but the upper parts could also operate if they extended down vertically or at any other convenient angle.

The assemblies 20, 21 contain electrolytic cells 60,62. It will be seen from Fig. 2 that there are six electrodes comprising a copper anode 22 in association with two stainless steel cathodes 23 and 24 to form cell 60, and a silver anode 25 in association with two

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stainless steel cathodes 26 and 27 to form cell 62, all being spacedly mounted as illustrated for the flow of water therewith. Fig. 2 shows the removable features of the upper parts which support the electrodes so that their fixing ends are interconnected and have 5 respective circuit means 28 and 29 through plug-in means 30 and 31 (see Fig. 2) for connection in circuit to the control box 32. The control box 32 may receive electrical power from the same source that activates an electrical pump used to pump the water to the supply line or pipe 15. In turn, current is caused to flow between the 10 electrodes, and at the same time a pump 33 will be actuated to draw  $H_2O_2$  from a reservoir 51 to an entry port assembly 34 in housing 10. Entry port assembly 34 may be threadably engaged with flow line 13 so that its inner end is a delivery nozzle within flow line 13 whilst its outer end receives a supply tube, preferably nylon, coupled to pump 15. Pump 33 is of the peristaltic type but any suitable pump may be substituted. Pump 33 ensures that  $H_2O_2$  is forced non-returnably into the pressurised water flow line 13. The operating pressure of pump 33 may be manually adjustable by means of control means 39 in Fig. 1. Pump 33 may, if required, be replaced by a gravity feed device or 20 solenoid operated valve arrangement.

Figs. 4 and 5 show a self-opening tube 35, preferably formed from stainless steel, having a lower cutting end 36 with cutting edges 37. Cutting edges 37 provide a self-drilling or tapping feature which allows tube 35 to be inserted into a sealed container 51 of 25  $H_2O_2$ . The cutting end 36 of stainless steel tube 35 is so shaped and designed as to allow full flow and at the same time be capable of performing a self-centring drilling action when turned like an auger. After the drilling has been completed tube 35 may be inserted to the full depth of container 51. Accordingly, an operator will not be 30 exposed to  $H_2O_2$  and no skin irritation can occur. Cutting edges 37 will also not impede flow of  $H_2O_2$  into the tube 35. Near the  $H_2O_2$ ,

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5 container 51, the upper externally-exposed part of the inserted stainless steel tube 35 has a T-section arm fitted with a needle valve 38 for manual control. From this branch, other liquids that may be required from time to time may also be introduced into the water, such as hydrochloric acid or sodium hydroxide to obtain a pH balance, or to introduce corrosion inhibitors such as polyphosphates.

10 Fig. 1 also shows two current meters 40 and 41 for the copper and silver units, respectively, with manual knobs 42 and 43 for adjustably varying the rheostats 44 and 45 shown in the circuit diagram of Fig. 3. Numeral 46 indicates the power supply in, and the numerals 47 and 48 indicate the power supply out in respect of the two heavy metal units. The gauges or meters 40 and 41 are also shown in Fig. 3, each having resistor means indicated at 49 and 50.

15 The manner of operation will now be described. On start up, water flows in through supply pipe 15 and enters treatment housing 10. Pump 33 will draw  $H_2O_2$  from container 51 and dispense the  $H_2O_2$  through entry port assembly 34 into flow line 13. Electrolytic cells 60,62 will be activated to release copper and silver ions respectively into flow line 13. By placing the copper electrode 22 upstream of silver electrode 25 a synergistic reaction occurs with respect to the copper and silver ions released into the water and the  $H_2O_2$ . Total catalysation of  $H_2O_2$  will occur resulting in hyper-oxygenation of the water. This contrasts with the prior art where hydroxyl production can occur. The introduction of the  $H_2O_2$  after 20 release of the copper ions and prior to the release of the silver ions provides this unexpected optimum hyper-oxygenation. By having silver electrode 25 downstream of copper electrode 22 the tendency of silver ions to silver plate the copper electrode is also substantially reduced and copper ion release is not hindered. This results in more 25 effective use of the silver and a reduction in downtime for cleaning electrodes. The upper assemblies 20,21 are readily removed when 30

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desired, as will be the need in applications where copper, in particular, may become an electrolysis corrosion problem eg cooling towers.

In trialing and field testing the apparatus as aforescribed, it  
5 has become apparent that the commercial viability of the technology  
therein could be enhanced by improvements relative to service  
aspects thereof. In this regard two main aspects of servicing have  
become apparent being regularly occurring problems involving  
additional manpower and time namely (1) cleaning of the anode and  
10 (2) replacing used anodes.

Naturally it is not possible to ameliorate the need to replace  
anodes as they are consumable items, and thus attention was  
directed to the development of a system which will eliminate the  
aspect of cleaning the anodes and in consequence extend the service  
15 life whereby anodes are replaced less frequently.

As Fig. 6 is very similar to Fig. 2 the same reference numerals  
will be used to show integers identical to those in Fig. 2. As shown  
in Fig. 6 stainless steel cathodes 23,24 of the earlier embodiment  
have been removed and replaced by copper electrodes 64,66.  
20 Electrodes 64,66 are of the same size and composition as centre  
copper anode 22. Similarly, stainless steel electrodes 26,27 are  
replaced by silver electrodes 68,70. Reference should be made to  
Fig. 7 which shows the power supply and wiring circuit diagram to  
supply up to a 6v DC adjustable reversing current to the electrodes  
25 22,64,66,25,68,70. An alternating current 72 is supplied through  
switch 74 and its voltage can be controlled by variable impedance  
76. A transformer 78 reduces the alternating voltage to allow  
rectification to direct current by bridge rectifier 80. The direct current  
is connected to the contacts of a relay 82. A timer 84 controls relay  
30 82 by switching the sets of contacts between the two illustrated

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positions. An ammeter 86 may be provided to give a visual indication of the current being drawn.

In the position shown in Fig. 7 positive terminal 88 will be connected to the anodes 22,25 whilst negative terminal 90 will be connected to the cathodes 64,66,68,70. As can be seen when timer 84 times out the relay contacts will be shifted causing terminals 88,90 to be reversed with terminal 88 becoming negative whilst terminal 90 will become positive. The reversing of the polarity is timed so as to create an even wearing and cleaning of all electrodes.

Accordingly, central electrodes 22,25 will be anodes with the pairs of outer electrodes 64,66;68,70 being the cathodes, and when the current is reversed the centre electrodes 22,25 will be the cathodes and the outer electrodes 64,66;68,70 will be the anodes. This will allow cleaning of the anodes which attract different contaminants when acting as anodes. Copper and silver ions can be thus produced continuously in a cleaning mode. In practice, by setting timer 84 to activate the centre electrodes 22,25 as anodes for, say, 15 minutes and then reversing the polarity for, say, 30 minutes the outer two electrodes 64,66;68,70 are activated as anodes, an optimum condition is met. This switching can be repeated in a continuous manner. Such a procedure will increase the life of the electrodes by up to three times.

Figs. 8 and 9 show how the even wearing of all electrodes will take place. In Fig. 8 central electrodes 22,25 are acting as anodes and will release metal ions from two opposing surfaces 92,94 at the one time as shown by the arrows. However, once the current is reversed and the outer electrodes 64,66;68,70 act as anodes (Fig. 9), metal ions will be released from only one side 96,98 of each electrode 64,66;68,70, thus requiring twice as much time to reduce the size of the outer electrodes to the same size as the middle electrodes 22,25, and to produce the same amount of metal ions per

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minute as when the centre electrodes 22,25 acted as anodes. It will be apparent that at no time during the operation of the system will the release of metal ions be restricted.

It has been previously mentioned that the invention provides 5 improvements in liquid purification apparatus, and it will be understood that there are many applications for purified water apart from drinking purposes. Not only is purified water desirable in pools and similar bodies of water, but it can be important for water used in hosing down carcasses and food containers for example. Also 10 with increased demand for usage of sewage water for golf courses and golf greens, the invention is capable of disinfecting sewage water which is thereafter sprayed or otherwise applied to the golf greens or fairways, these being examples which further show the wide application of the invention.

15 The invention will be understood to embrace many further modifications as will be readily apparent to persons skilled in the art and which will be deemed to reside within the broad scope and ambit of the invention, there having been set forth herein only the broad nature of the invention and certain specific embodiments by way of 20 example.

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#### CLAIMS

1. A liquid purification apparatus adapted to employ the combination of the purifying affects of the heavy metals copper and silver in conjunction with hydrogen peroxide and the catalytic reaction thereof, said apparatus including body means defining a flow passage having a liquid inlet at one end and a liquid outlet at the other end, said flow passage containing a first electrolytic unit containing at least one copper based anode, a second electrolytic unit containing at least one silver based anode spaced downstream of said first electrolytic unit, electrical circuit means being provided in association with the electrolytic units for supplying operating current thereto, and said flow passage including an inlet for the controlled introduction of  $H_2O_2$  from reservoir means into said flow passage between said first and second electrolytic units.
- 15 2. The liquid purification apparatus as claimed in claim 1, wherein said controlled introduction of  $H_2O_2$  is through a pump.
3. The liquid purification apparatus as claimed in claim 2, wherein said pump is of the peristaltic type.
4. The liquid purification apparatus as claimed in any one 20 of the preceding claims, wherein each electrolytic unit includes a single anode having a pair of stainless steel cathodes at equal distances on opposite sides of said anode, said anode and cathodes being spaced apart along and within said flow passage.
5. The liquid purification apparatus as claimed in any one 25 of claims 1 to 3, wherein each electrolytic unit includes a single anode having a pair of cathodes made of the same material as the anode on opposite sides of said anode, said anode and cathodes being spaced apart along and within said flow passage direction and electric control means to cyclically reverse the polarity of said anode 30 and cathodes to effect a self-cleaning of said anode and cathodes.

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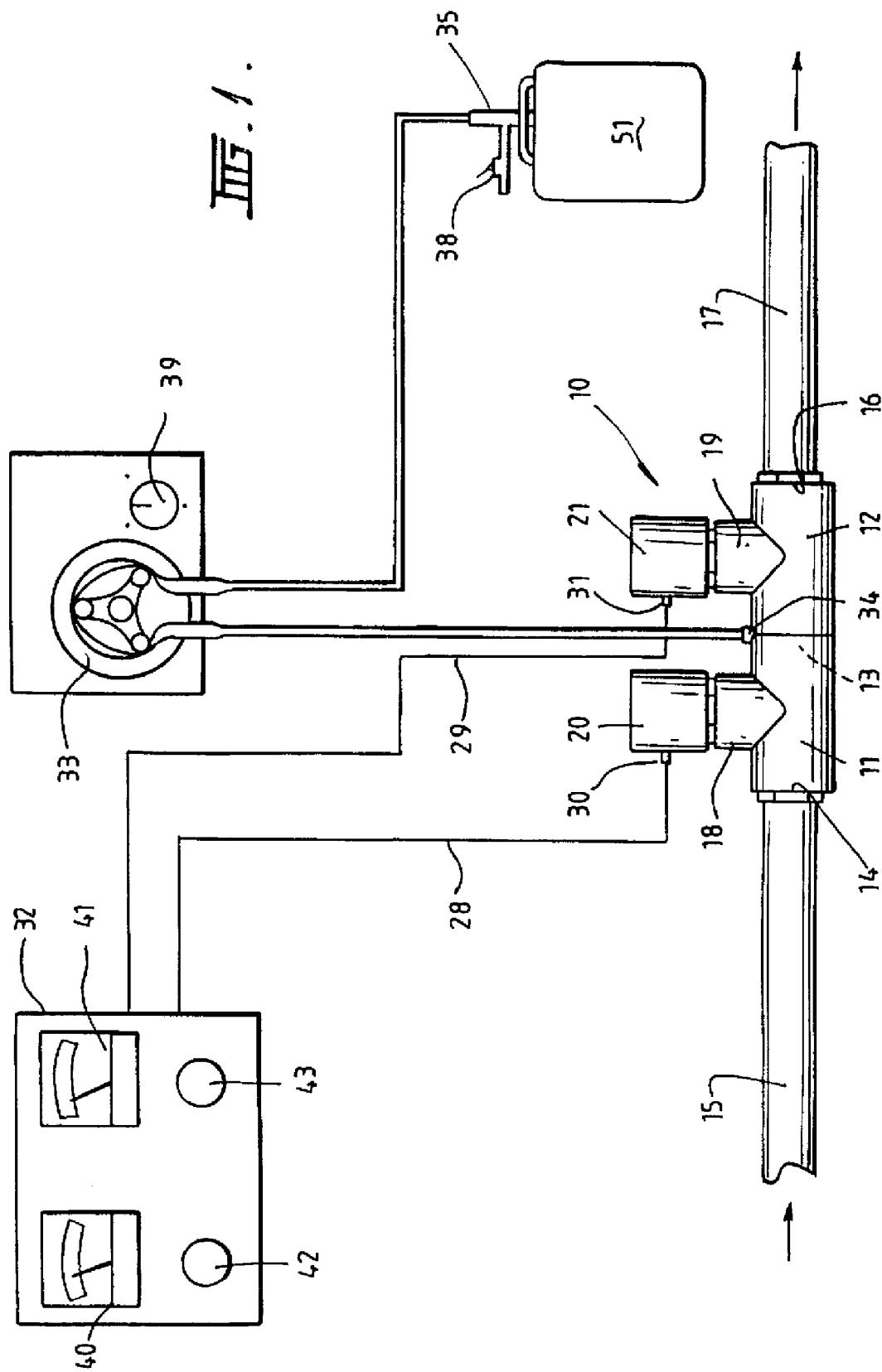
6. The liquid purification apparatus as claimed in any one of the preceding claims, wherein each electrolytic unit is mounted in an upper removable mounting assembly.

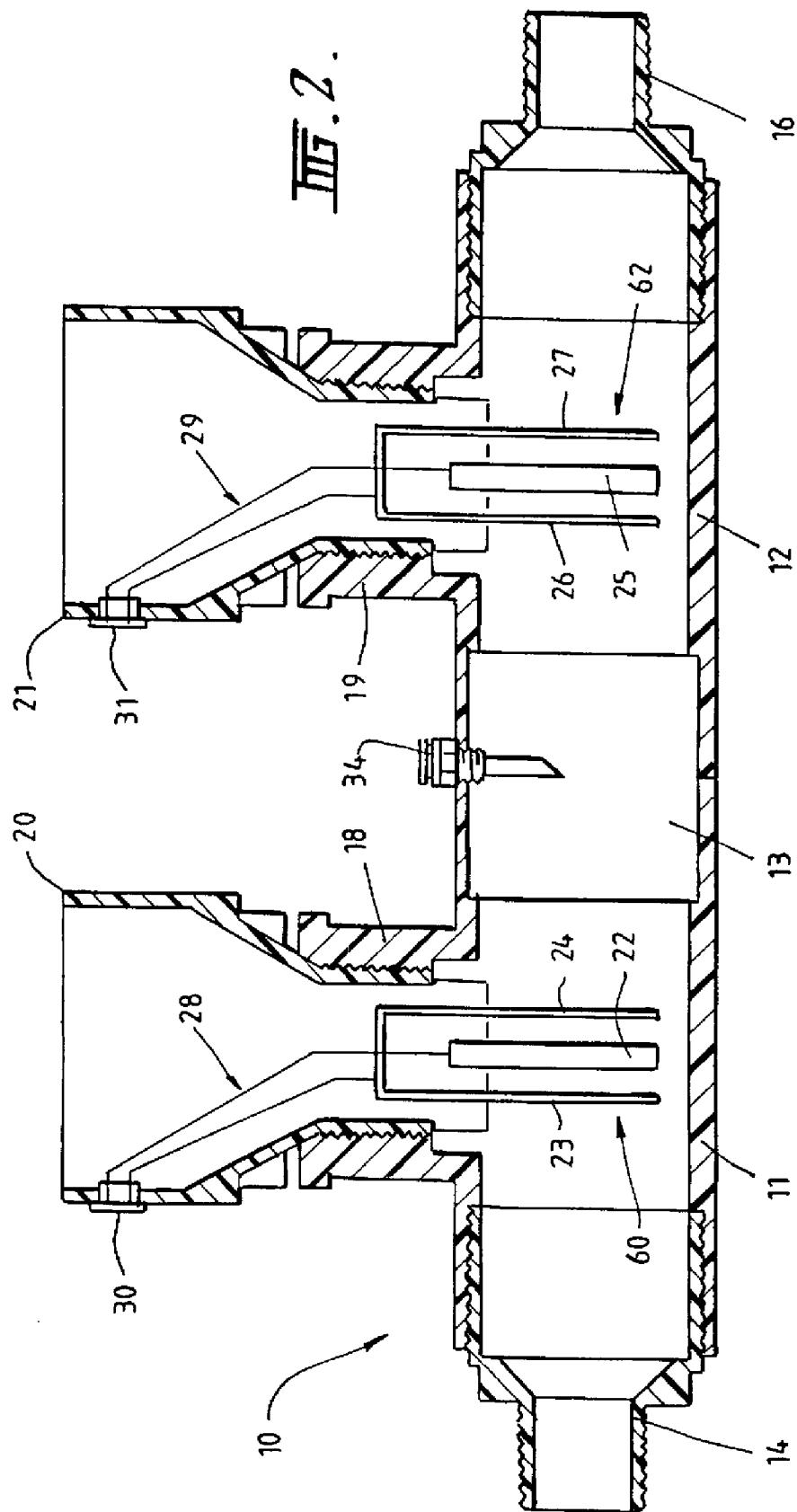
7. The liquid purification apparatus as claimed in claim 2 or 3, further including a tube having a free end adapted to drill into a sealed container forming said reservoir, said tube adapted to be inserted to the full depth of said container to allow said H<sub>2</sub>O<sub>2</sub> to be drawn from said container by said pump.

8. The liquid purification apparatus as claimed in any one of claims 1 to 6, wherein said reservoir means is a sealed container.

9. The liquid purification apparatus as claimed in any one of the preceding claims, wherein said inlet for the controlled introduction of H<sub>2</sub>O<sub>2</sub> from said reservoir means into said flow passage comprises a delivery nozzle projecting into said flow passage.

10. The liquid purification apparatus as claimed in claim 7, further including a branch in said tube for connection to at least one further container containing a solution.





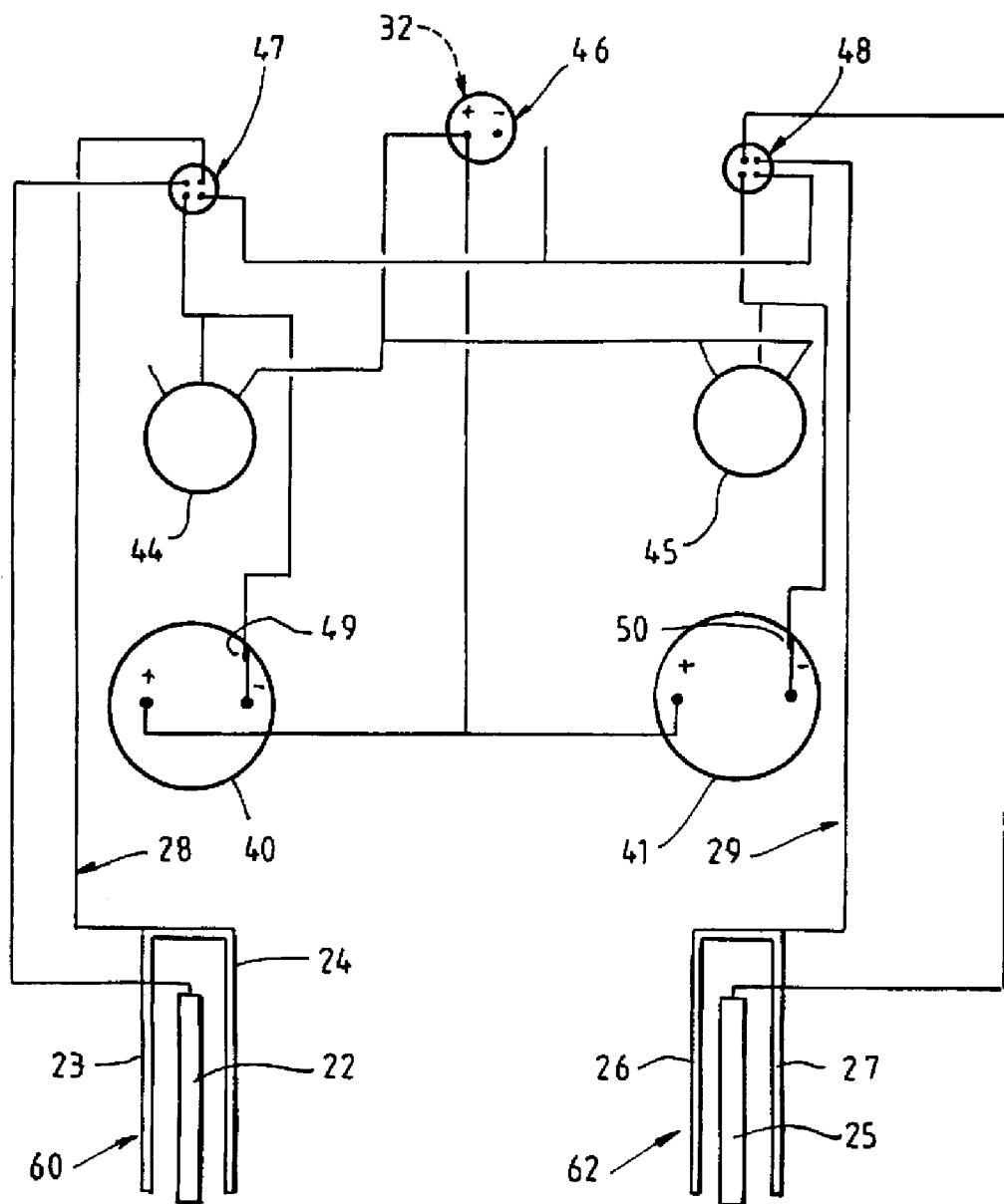
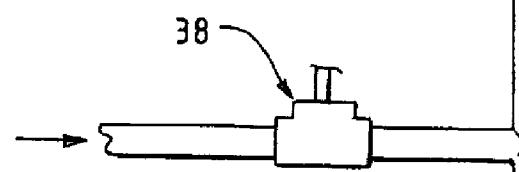
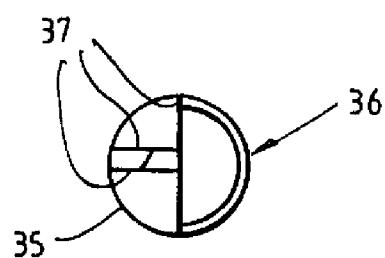


FIG. 3.

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FIG. 4.

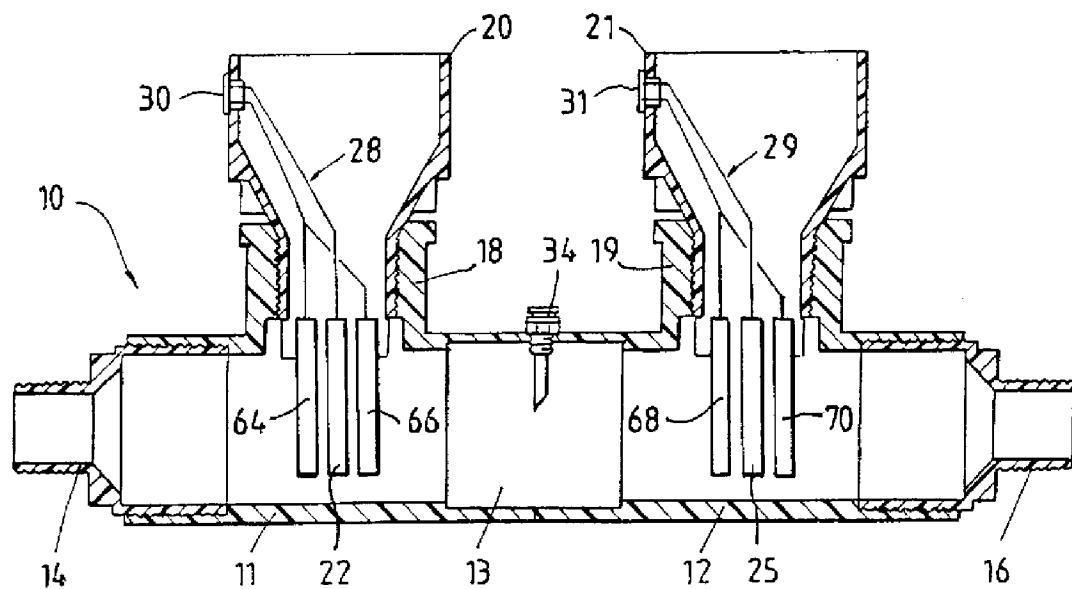
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FIG. 5.

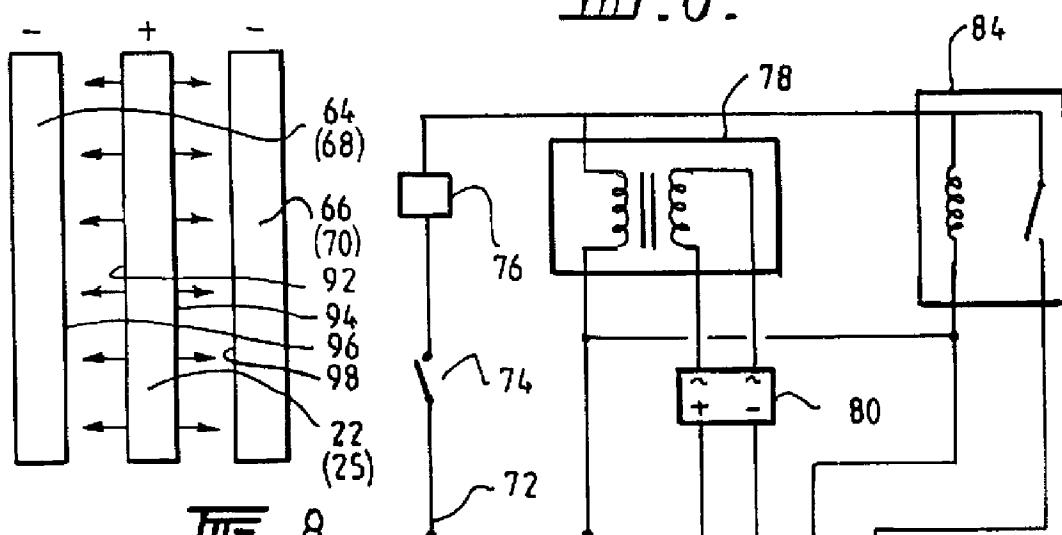
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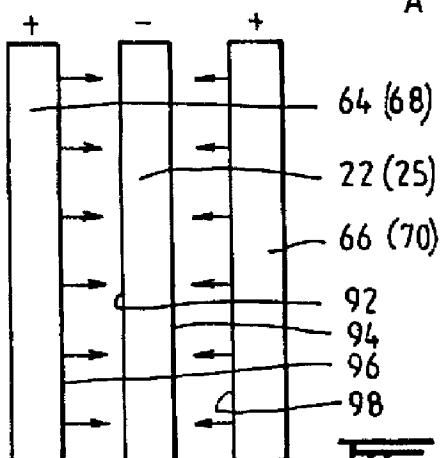
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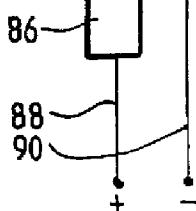
III. 6.



III. 8.



III. 7.



III. 9.

# INTERNATIONAL SEARCH REPORT

International Application No.  
PCT/AU 96/00768

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>		
Int Cl <sup>6</sup> : C02F 1/467, C02F 1/50, C02F 1/72		
According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
Minimum documentation searched (classification system followed by classification symbols) C02F 1/467, 1/50, 1/72, 1/46 AND C02B 1/82, 3/10, 3/08		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched AU : IPC as above		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) DERWENT : (SILVER or AG or COPPER or CU or CUPR:) AND (H <sub>2</sub> O <sub>2</sub> or HYDROGEN ( ) PEROXID( )) CHEM ABS : (AS FOR DERWENT) AND (DISINFECT( ) or STERIL( ) or CLEAN( ))		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2, 105, 835 A (KRAUSE) 18 January 1938 Page 1, column 1, lines 37-40, page 2, column 1, lines 52-60, and claims 1, 2, 8, 9, 10	1-10
Y	CH 605, 421 A (SCHWEIZERISCHE SODAFABRIK, ZURICH) 29 September 1978 See Derwent Abstract Accession No. 72895A/41 and specification, column 1, lines 34-52, main claim, and sub-claims 1, 2	1-10
Y	GB 2, 270, 395 A (HONEYWELL CONTROL SYSTEMS LIMITED) 9 March 1994 Page 10, line 26 - page 11, line 14, page 16, lines 10-29, claims 1, 5-7, 26, 29	1-10
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex		
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Date of the actual completion of the international search 19 March 1997		Date of mailing of the international search report 11 APR 1997
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No.: (06) 285 3929		Authorized officer JIM LACKIE Telephone No.: (06) 283 2272 

**INTERNATIONAL SEARCH REPORT**

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<b>C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
<b>Category*</b>	<b>Citation of document, with indication, where appropriate, of the relevant passages</b>	<b>Relevant to claim No.</b>
Y	WO 9010734 A (SILVERI) 20 September 1990 Claims 16-20	1-10
Y	US 3, 654, 119 A (WHITE ET AL) 4 April 1972 Whole document	1-10
Y	PATENT ABSTRACTS OF JAPAN, C-961, page 158, JP 04-90886 A (MATSUSHITA ELECTRIC WORKS LTD.) 24 March 1992 Abstract	1-10
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**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International Application No.

PCT/AU 96/00768

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report				Patent Family Member				
WO	9010734	AU	33596/89	AU	27456/92	AU	26086/92	
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END OF ANNEX								